Computed Tomography Using the Diffraction-Enhanced X-Ray Imaging Method*	X15A

F.A. Dilmanian, B. Ren, X.Y. Wu, I. Orion (BNL Medical), Z. Zhong, W.C. Thomlinson (NSLS), and L.D. Chapman (IIT)

In conventional x-ray radiography, including computed tomography (CT), x-ray beams passing through an object undergo absorption, small angle scattering, and refraction processes, which give rise to the image contrast. These effects cannot be separated from each other. In the newly developed imaging method with monochromatic x-ray, the diffraction enhance imaging (DEI)[1], an analyer crystal is applied to diffract the beams from the object into the detector. The narrow acceptance angle of the analyzer enables the detection of the out-of-plane x-ray refraction from the subject, as well as the reduction of small angle scattering which compromises the image contrast in conventional radiography. As a result, separate images of a) attenuation with reduced scattering content, and b) refraction process can be obtained, using images acquisited at distince points over the system's rocking curve.

We implemented monochromatic x-ray CT with DEI method using the NSLS's X15A beamline. The goal was to develop a method of cross-sectionally characterizing tissues with the DEI technique. The beam energy was 22 keV, and the beam height was 1.6 mm. CT projections were collected with a speed of 15 second/turn at the analyzer-tuned position, and at ± 1.5-μradian detuned ones. A 2-inch acrylic cylindrical phantom that included four non-paraxial oil-filled cylindrical channels was imaged transaxially with an in-plane spatial resolution of ≈ 0.25 mm. Standard filtered back-projection (FB) algorithm was applied to reconstruct the refraction CT images. The pixel values at the inner and outer edges of the four oil channels (along the phantom's radii) in arbitrary unit were: -0.56 and +0.56 for the 5^o-tilt channel; -1.05 and + 0.92, and +0.95 and -0.97 for the two 10^o channels; and +1.25 and -1.32 for the 15^o channel. The background value was 0.0 ± 0.05, rendering a signal-to-noise ratio of about 11:1 for the 5^o tile channel. The results show that, DEI-CT image can be reconstructed with FB, the refraction image can be produced with almost free of small-angle scattering, and the contrast in the refraction image is portional to the gradient of the refraction index.

*This research has been supported by the U.S. Department of Energy.

[1]Chapman, Thomlinson, et al., Phy. Med. Biol. 42:2015-2025, 1997.